

TO: All Design Section Staff
FROM: Bijan Khaleghi
DATE: July 1, 2013
SUBJECT: Bridges with MSE wall supported abutments

This design memorandum defines WSDOT policy for the use of Mechanically Stabilized Earth (MSE) wall supported abutments for single or multi-span bridges. This design memorandum supersedes the design memorandum issued on June 2012.

For the purpose of this policy memorandum, MSE walls shall be taken to include geosynthetic retaining walls (with and without structural facing) and structural earth walls.

MSE wall supported abutments shall be designed in accordance with the requirements of this policy memorandum, as well as following documents in order of hierarchy:

- WSDOT Geotechnical Design Manual section 15.5.3.5 for MSE Wall Supported Abutments
- AASHTO LRFD Bridge Design Specifications, 6th Edition 2012.
- FHWA NHI-10-024 Volume I and NHI-10-025 Volume II, “Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes,” (Berg et al., 2009)

Bridges with MSE wall supported abutments shall be categorized as one of two types described below, and shall meet the associated design requirements:

- 1) Single span bridges constructed with a precast slab superstructure supported directly on reinforced soil, as shown in Figure 1.
- 2) Single span bridge constructed with a precast slab superstructure supported directly on reinforced soil two stage wall with full height concrete panels, as shown in Figure 2.
- 3) All other bridges with spread footings supported directly supported by an MSE wall, as shown in Figure 3.

These limitations supersede the limitations of AASHTO LRFD Section 11.10.11

- 1. Single span bridges constructed with a precast slab superstructure supported directly on reinforced soil.**
 - The span length shall not exceed 60 feet.
 - The superstructure shall include a 5” thick C.I.P. composite topping.

- MSE walls shall be 30 feet or less in total height, which includes the retained soil height plus embedded depth, measured from bottom of superstructure to top of the reinforced soil foundation.
- The end of the precast superstructure shall be at least 4ft from the face of the MSE wall. Minimum seat width requirements shall be provided on the reinforced soil bearing area.
- A foam board detail shall be used to create a 1 ft. horizontal buffer between the bearing area and the MSE wall facing.
- The vertical gap between top of wall facing and bottom of superstructure shall be 4" or 2% of the abutment height, whichever is greater.
- Prestressing strands in the zone bearing on reinforced soil shall have a minimum concrete cover of 2". Transverse reinforcing steel within this zone shall have a minimum concrete cover of 1½". All prestressing strand shall be removed to a 2" depth from the end of the slab. The voids shall be patched with an approved epoxy grout.
- Where voided slab superstructures are used, the slab section shall be solid from the end of the slab to at least 1 ft. in front of the fascia.
- The abutment shall be designed for a bearing pressure at service loads not to exceed 2.0 TSF and a factored load at strength and extreme limit states not to exceed 3.5 TSF. The bearing pressure may be increased to 3.0 TSF at service loads and 4.5 TSF at strength and extreme limit states if a vertical settlement monitoring program is conducted in accordance with WSDOT GDM section 15.5.3.5.
- MSE walls supporting bridge abutments shall be special designed wall systems, and shall be one of two types:
 - Geosynthetic and structural earth walls with concrete facing.
 - Geosynthetic walls with a stacked dry-cast modular concrete block facing. The top 3 rows of dry-cast modular concrete blocks shall be grouted with #4 rebar.
- Bridge approach slabs may be omitted.

2. Bridges with spread footings supported directly on an MSE wall.

- MSE walls directly supporting spread footing bridge abutments shall be 30 feet or less in total height, which includes the retained soil height up to the bottom of the embedded spread footing.

- For SE walls, the front edge of the bridge footing shall be placed 4 ft. minimum from the back face of the fascia panel. For geosynthetic retaining walls with a wrapped face, the front edge of the bridge footing shall be placed 2 ft. minimum from the back face of the fascia panel.
- The abutment footing shall be covered by at least 6 inch of soil for frost protection.
- The superstructure of continuous span bridges shall be designed for any differential settlements between piers.
- Abutment spread footings shall be designed for bearing pressure at service loads not to exceed 2.0 TSF and factored load at strength and extreme limit states not to exceed 3.5 TSF. The bearing pressure may be increased to 3.0 TSF at service loads and 4.5 TSF at strength and extreme limit states if a vertical settlement monitoring program is conducted in accordance with WSDOT GDM section 15.5.3.5.
- MSE walls supporting bridge abutments shall be special designed wall systems. Only precast concrete panel faced MSE walls or cast-in-place concrete faced MSE walls may be used for permanent bridge installations. Dry-cast modular concrete block faced MSE walls and welded wire faced SE walls may be used for temporary bridge installations.
- To provide bridge inspection access, the bottom of the bridge superstructure to top of slope protection surface shall be 3 feet minimum for I-girder type bridges, and 5 feet minimum for non I-girder, slab and box girder type bridges. Fall protection shall be installed as required by the WAC.

Proprietary SE walls supporting abutments shall not be considered preapproved, and shall not be used beyond the limits described herein unless approved by the State Geotechnical Engineer and the Bridge Design Engineer.

Background:

This memorandum is intended to update WSDOT design policies on bridge abutments to include the use of systems similar to the Geosynthetic Reinforced Soil – Integrated Bridge System (GRS-IBS). The GRS-IBS method has been used increasingly around the country with success. The FHWA has developed a manual for this type of bridge abutment, provided on the following FHWA website:

http://www.fhwa.dot.gov/everydaycounts/technology/grs_ibs/

However, this memorandum and the referenced manuals provided at the beginning of this memorandum shall be considered to supersede the FHWA GRS-IBS manual with regard to design and material requirements.

Using MSE structures as direct bridge abutments can be a simplification in the design and construction of bridge abutments and may lead to faster construction of bridges. Additionally, it could result in construction cost savings due to elimination of tall abutments. This solution would also contribute to better compatibility of deformation between the components of bridge abutment systems, thus minimizing the effects of differential settlements and the undesirable “bump” at bridge / embankment transitions, reducing the life cycle cost of the bridge.

For water crossings with potential for scour, the structural design must be closely coordinated with the hydraulic design requirements.

If you have any questions regarding these issues, please contact Tony Allen at 360 709-5450 (AllenT@wsdot.wa.gov) or Bijan Khaleghi at 360-705-7181 (KhalegB@wsdot.wa.gov) .

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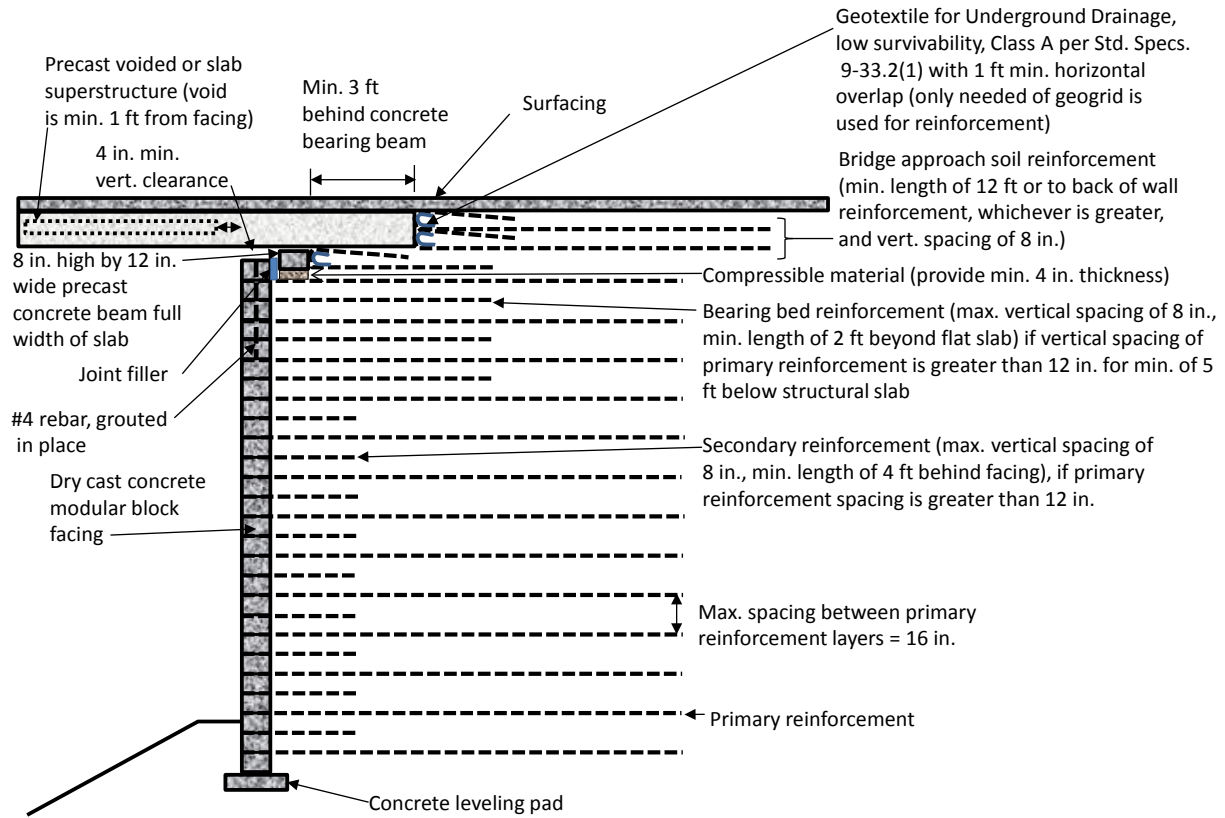


Figure 1. Typical Section – Single span bridge constructed with a precast slab superstructure supported directly on dry-cast concrete modular block faced reinforced soil wall.

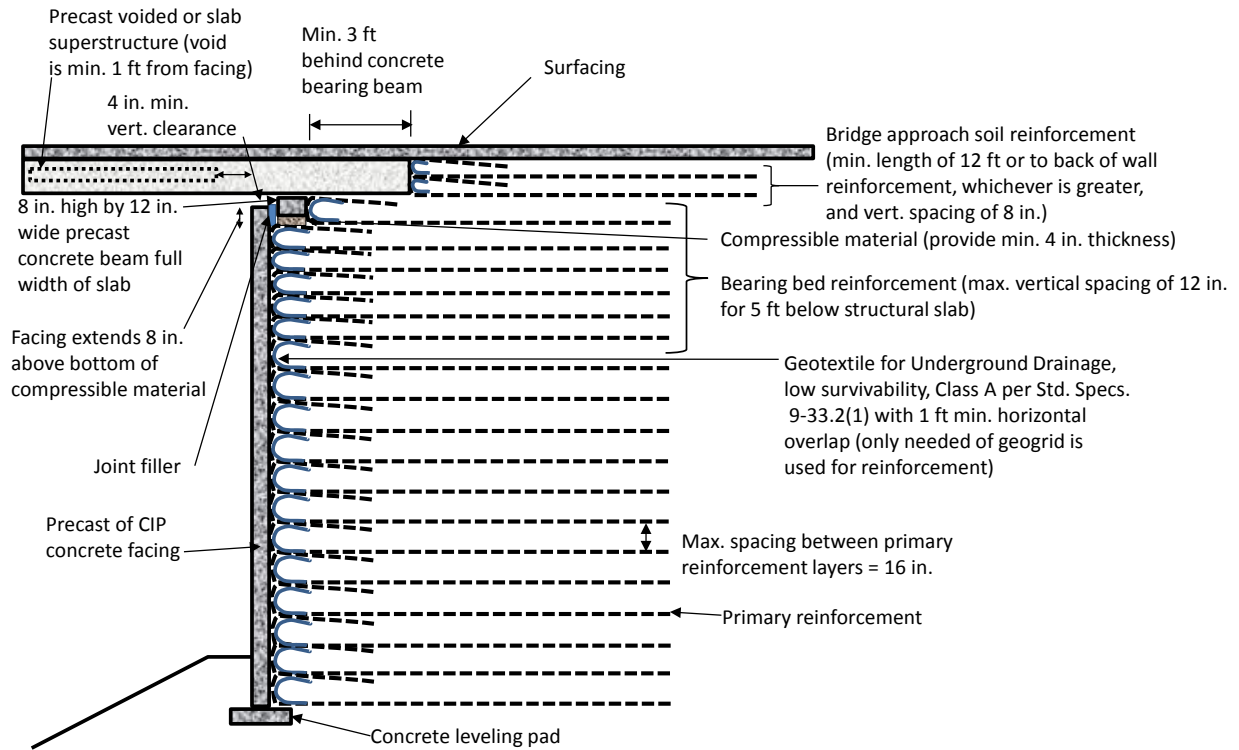
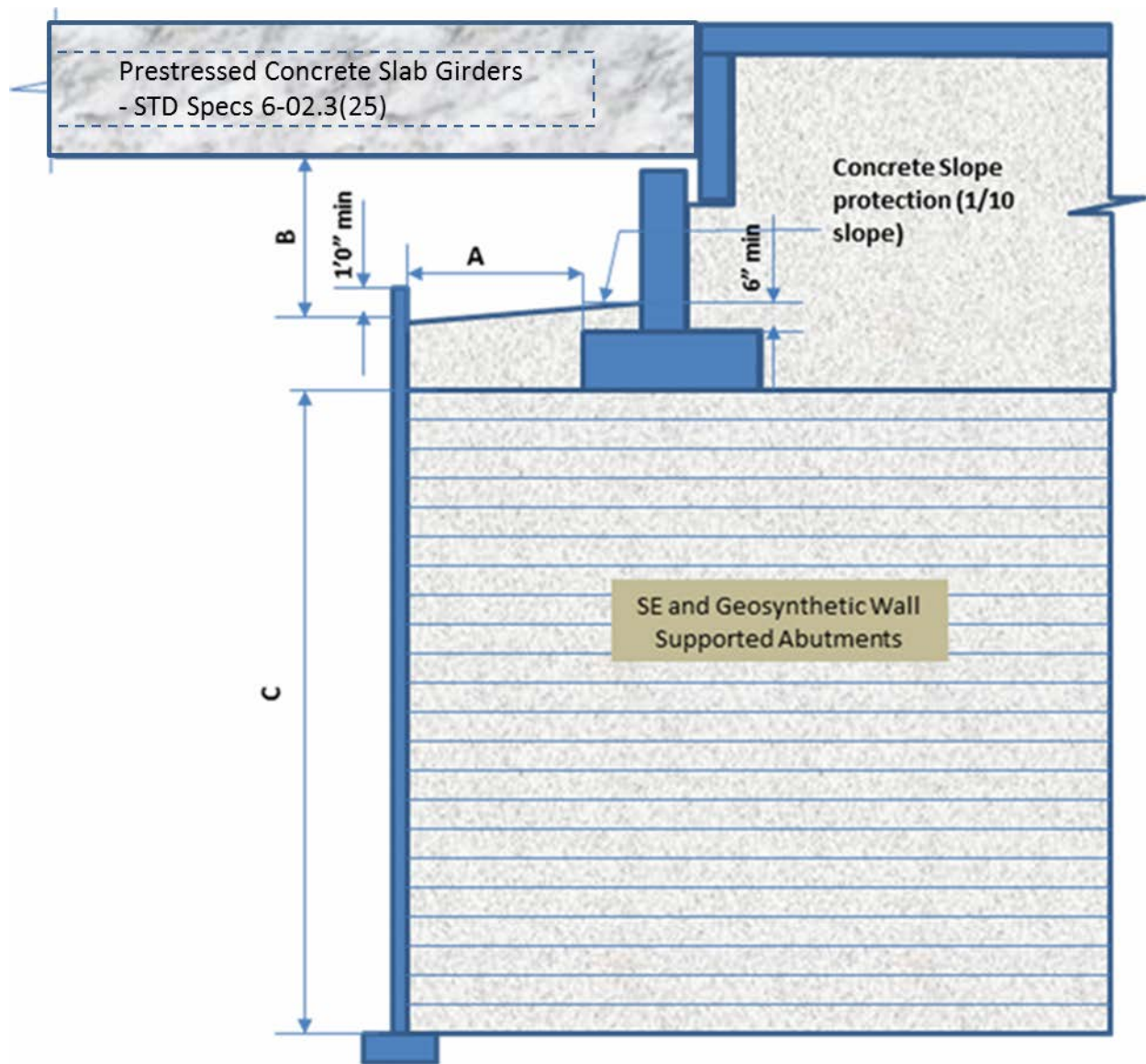


Figure 2. Typical Section – Single span bridge constructed with a precast slab superstructure supported directly on reinforced soil two stage wall with full height concrete panels.



- A. 4 ft min for SE Walls (precast concrete panel face or cast-in-place concrete face) and 2 ft min for special designed Geosynthetic retaining walls with wrapped face
- B. 3 ft min for I-girder bridges and 5 ft min for non-I-girder, slab, and box girder bridges
- C. 30 ft max

Figure 3. Typical Section – Bridge with spread footing supported directly on an MSE wall
Semi-integral abutment shown, L-abutment similar. Wing/Curtain Wall not shown